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SOME OBSERVATIONS ON THE BEHAVIOUR OF INCUBATING CHARADRIUS ALEXANDRINUS ON HOT SUMMER DAYS

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The midsummer, June to August, in Iraq is without rain and is featured by high temperature and low relative humidity. The habit of nesting in open dry areas and the rather tame nature of Kentish Plover **Charadrius alexandrinus** makes it an ideal subject for field study. Finding of Kentish Plover nesting in June provided us an opportunity to make some general observations on its adaptations for breeding in desert environment.

No previous study on the behavioural adjustments of Kentish Plover to a hot-climate-nesting exists other than that of Dharmakumarsinhji (1964). He recorded for the first time the wetting of belly feathers: "In the hot hours, the change over of duties at the nest was frequent and the bird taking over would often have its breast wet to keep the eggs moist." and the bird on nest calling characteristically, which was replied by the mate and change over taking place immediately.

Our study shows that almost all the methods known to reduce heat stress in birds are exploited by Kentish Plover nesting in arid-zone.

The Kentish Plover, a cosmopolitan species, breeds in Iraq from March to July, inclusive (Marchant 1963). Two nests were located on 23 June 1972 at Rashidiya, near Baghdad in a dried up portion of a temporarily flooded area by the side of Baghdad-Baquba road. The soil, a mixture of sand and silt, was grey. Although the area was dry during daytime, late at night and early morning many portions looked wet from the rising of subsoil water. Bushes 1 to 1.5 m high were growing scattered (Fig. 1). One nest was in open (Fig. 2), the other under a bush (Fig. 3); the latter was completely in shade from sun till 1100. Both contained the usual clutch of three eggs. The eggs in open nest at the time of finding (0800) were partially covered with loose sand but when examined on the same day at 1400 and 1830 all the eggs were exposed. Collared Pratincoles **Glareola pratincola** and Little Terns **Sterna albifrons** were nesting (incubating) at the time of our observation. Used nests of Blackwinged Stilts **Himantopus himantopus** were present.

Males of both nests were distinguishable from females in having black lores, ear-coverts, and a band below eye. These regions in females were lighter (Figs. 9 & 10). We made the observation between 23 and 30 June from hides using 7 x 30 binoculars and 40 x 60 telescope.

Fig. 1. Breeding area of Kentish Plover, Rashidiya, Baghdad.

Fig. 2. Nest in open with the usual clutch of three eggs.

Fig. 3. Nest under bush (= shaded nest) with a clutch of three eggs.

The soil temperature was taken by piercing a mercury thermometer into the sand till the mercury bulb was completely in, near the hide in an area exposed to direct sun. The shade air temperature was measured about one metre above ground close to hide.

RESULTS

Our observations are limited to the general activities of the incubating bird from late after sunrise till soon after the eggs were left unattended in the evening.

Except for the short absences caused by disturbances, the eggs were continuously covered by one of the parents till evening. The change over was close hence the eggs were exposed to sun only for a short time. During the heat of the day the bird coming for incubation had its belly soaked in water, and panting and gular fluttering a regular feature in the sitting bird. In the evening when the intensity of solar radiation was reduced together with the soil and air temperatures, the eggs were left unattended. On all the four occassions, covering both nests, female was on nest for the last evening sitting.

NEST ATTENTIVENESS

The nest attentiveness by both male and female observed in the shaded nest for two days are plotted in Fig. 4. Short absences from the nest owing to disturbances (such as a pratincole call and the like) during which the bird was making repeated attempts to come and settle - are not considered as inattentiveness for the present study. The nest attentiveness for the above nest for two days and one day for open nest during the observed period was cent percent excepting the three instances mentioned below of the former nest.

On two occasssions we had the chance to note what would happen in case the partner fails to relieve the sitting bird. On 30 June female was on nest in one stretch for 86 minutes from 1614. Towards the end it was getting increasingly restless by way of getting up, shaking itself, changing position and orientation in nest. At 1740 it left the nest and flew off. Ten minutes later the same bird returned and resumed sitting on eggs. The belly feathers were not wet at this time and probably it had gone for a drink. On 28 June male attending the nest continuously for 85 minutes left it at 1710 and flew off. Its partner did not come for

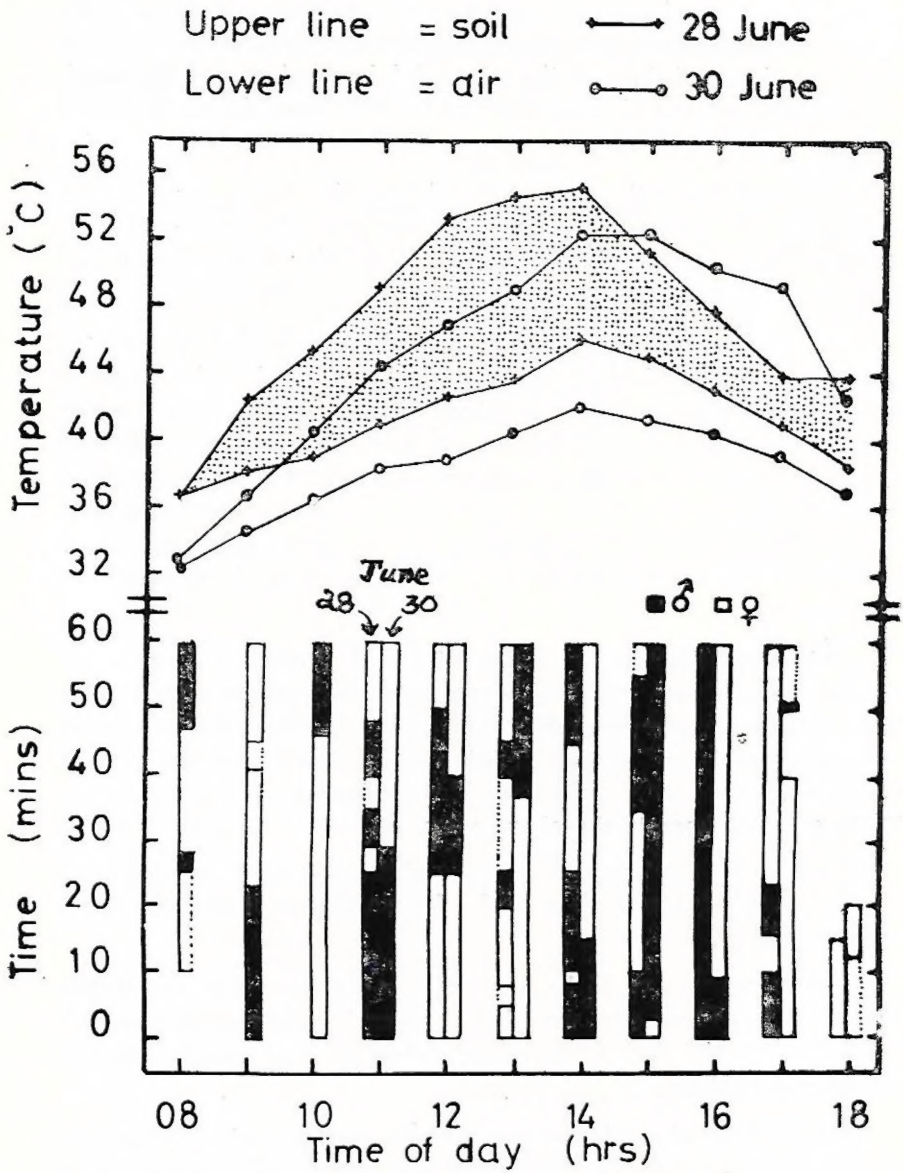

Fig. 4. The nest attentiveness of a pair of Kentish Plover in a shaded nest on 23 (left side) and 30 (right side) June together with soil and air temperatures. dots = bird in nest vicinity, black = male, white = female.

relief. The same bird came back after six minutes and sat on eggs. Seven minutes later female came and change over took place. These two penultimate sittings of the same bird in evening were the maximum single nest attentiveness recorded for both sexes during the observation.

The third inattentiveness occurred in morning for 19 minutes from 0828 when the male attending the nest was probably disturbed by the observer. The eggs were in shade, the soil and air temperatures at that time were 35° and 34°C respectively.

The attentiveness in shaded nest for the same period of two days with different ambient temperatures, Ta, are given in Table 1. On 28 June, when the Ta was higher than on 30 June, the number of attentive periods increased from 4 to 8 and the average duration of single nest attentiveness decreased from 43 to 29.5 minutes by male. The same for female was 5 to 7 and 53.4 to 27.5 respectively. The male's attentiveness on 30 June of 36.3% was increased to 54.2% on 28 June, which releived the load on female from 61.4% to 44.4% on 28 June.

This shows that the incubating birds adjust themselves to an increased Ta by decreasing the average duration of single attentiveness and by increasing the number of changeover. The increased number of attentive periods and shorter duration of single attentiveness seen in open nest compared to shaded nest for the same period and day (see Table 2) also supports the above view.

Overall results show that male's sitting averaged 26.0 minutes (n 28, range 3-85) and the same for female was 29.8 minutes (n 27. range 4-86).

One or two eggs could be seen at times not covered by the sitting bird (Fig. 5). These eggs were left uncovered sometimes as much as eight minutes, till they were brought below the bird usually when it got up and resettled.

The general orientation of the bird on eggs was with its back to the sun. Feathers of the back and nape were opened up during the heat of the day when there was refreshing wind. On the contrary, when the wind blowing was a hot one the bird did not open up the feathers. The bringing down of both wings to the ground to protect the eggs from hot

Table 1. Nest attentiveness (in minutes) for the same period of two days with different ambient temperatures* in a shaded nest.

	1100 to 1815	
	28 June	30 June
Total for male	236 (54.2%)	158 (36.3%)
No. of periods	8	4
Average	29.5	43.0
Range	7-85	20-71
Total for female	193 (44.4%)	267 (61.4%)
No. of periods	7	5
Average	27.5	53.4
Range	4-52	30-86

* see Fig. 8.

Table 2. Comparison of nest attentiveness in open and shaded nests.

	28 June ; 1100 to 1545	
	Open*	Shaded
Total for male	117 (47.4%)	144 (50.5%)
No. of periods	8	6
Average	14.6	24.0
Range	3-27	19-25
Total for female	130 (52.6%)	141 (49.5%)
No. of periods	8	6
Average	16.2	23.5
Range	8-23	4-37

* with one break in observation from 1305 to 1346.

wind as well to shade them from sun resulted in exposing the white side of tail (Fig. 6) which was normally covered by wing tips.

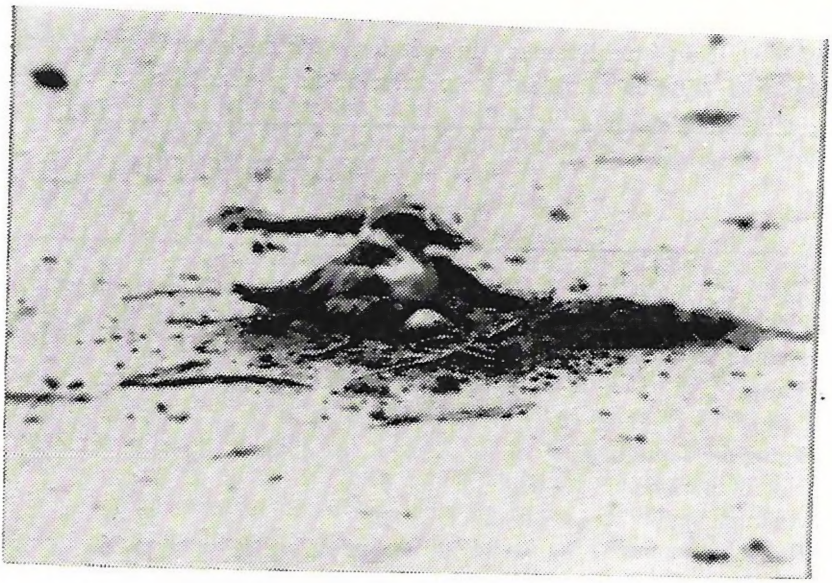

Fig. 5. One or two eggs were occasionally left uncovered while bird sat on eggs. These were brought under the bird when it got up and resettled.

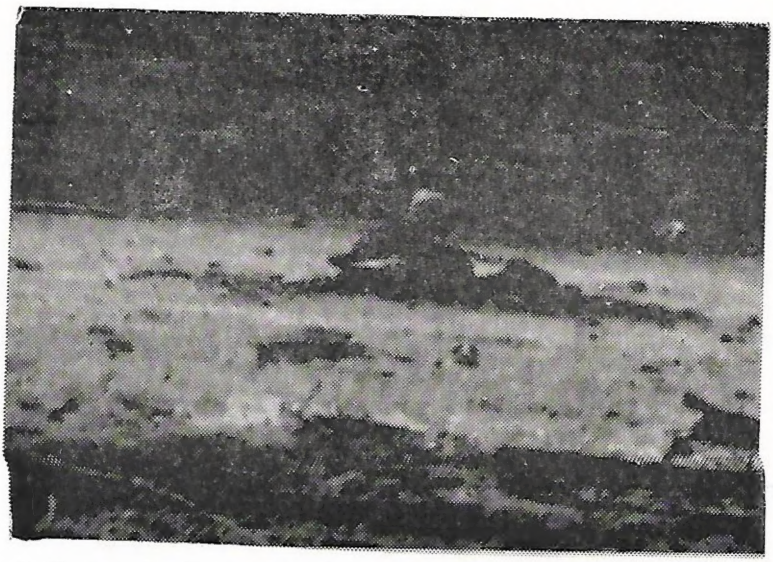

Fig. 6. During the heat of the day the bird on nest brought wings to the ground which resulted in exposing the white of tail.

While on nest the sitting bird got up many times, shook the body with feathers partly raised, and settled. Changing of position was also common. During the day from morning till evening the eyes of the sitting bird were wide open and on alert. But by evening after days strenuous work, when solar radiation, air and ground temperatures were subsided, the sitting bird looked tired, at times eyes closed, most of the time winking.

WETTING OF BELLY FEATHERS, PANTING, AND GULAR FLUTTERING

Open Nest

On 28 June when observation started at 0835 no birds were around the nest, probably moved away by being disturbed by our erecting of hide. At 0910 male arrived, after several hesitated attempts, settled on nest, when the belly feathers were soaked in water. From 0930 the bill was partly opened. At 0950 female with wet belly took over the incubation. The panting and gular fluttering noticed while the bird was settling on eggs were stopped after a few minutes. By 1010 male came with wet belly and sat on eggs, started open-bill panting and gular fluttering. Thereafter inclusive of the last changeover at 1750 by female, the incoming bird (for incubating) invariably had belly feathers soaked in water. The open-bill panting (Fig. 7) and gular fluttering were continuous in the bird on eggs till evening. We have no notes at what time these activities were discontinued on this evening.

Five days prior to the above observation we recorded the termination of panting and gular fluttering in the evening . The penultimate sitting in evening by male with wet belly began at 1545. Fast gular pulsation and open-bill panting were observed till 1655, thereafter the intensity of gular flutter appeared to have decreased. However, these were present even when the female with wet belly took over at 1633. Gular fluttering was clearly visible till 1713, and a few minutes later panting stopped, although the bill was more often kept open till 1723.

Shaded Nest

The female, which was continuously on nest for fifty minutes, started panting at 1035 and soon gular fluttering followed. At 1046 male with wet belly (first bird to arrive so) took over duty on nest.

After twenty-nine minutes open-bill panting began, and sixteen minutes later at 1145 gular fluttering started. Thereafter open-bill panting and gular fluttering were continuous in the bird on nest till evening and invariably the incoming bird had belly feathers soaked in water. The last wetting was at 1614 when female came for attending the nest. The last gular flutter on record was at 1632 and the panting at 1655.

During the continuous open-bill panting and gular fluttering the lower bill, kept slightly downturned, had a drop of watery liquid. When the size of this drop increased and on the verge of falling, it was brought back in the bill by the snapping movement and ?slight rai ing of bill. This drop did not seem to have taken in.

Open-bill panting started first followed sooner or later by gular fluttering ; the latter stopped first followed by the former. Soaking of belly feathers occurred either before the start of the above activities as in open nest, or after as in shaded nest (Fig. 8). Both male and female soaked their belly feathers (Figs. 9 & 10). The soaking of belly and subsequent sitting on ground nest resulted in giving a soiled isabelline tinge to the white ventral feathers. In the only two instances we have on record it was the male to arrive first with wet belly.

Fig. 7. Open-bill panting and gular fluttering were a regular feature in incubating bird during the hotter part of the day.

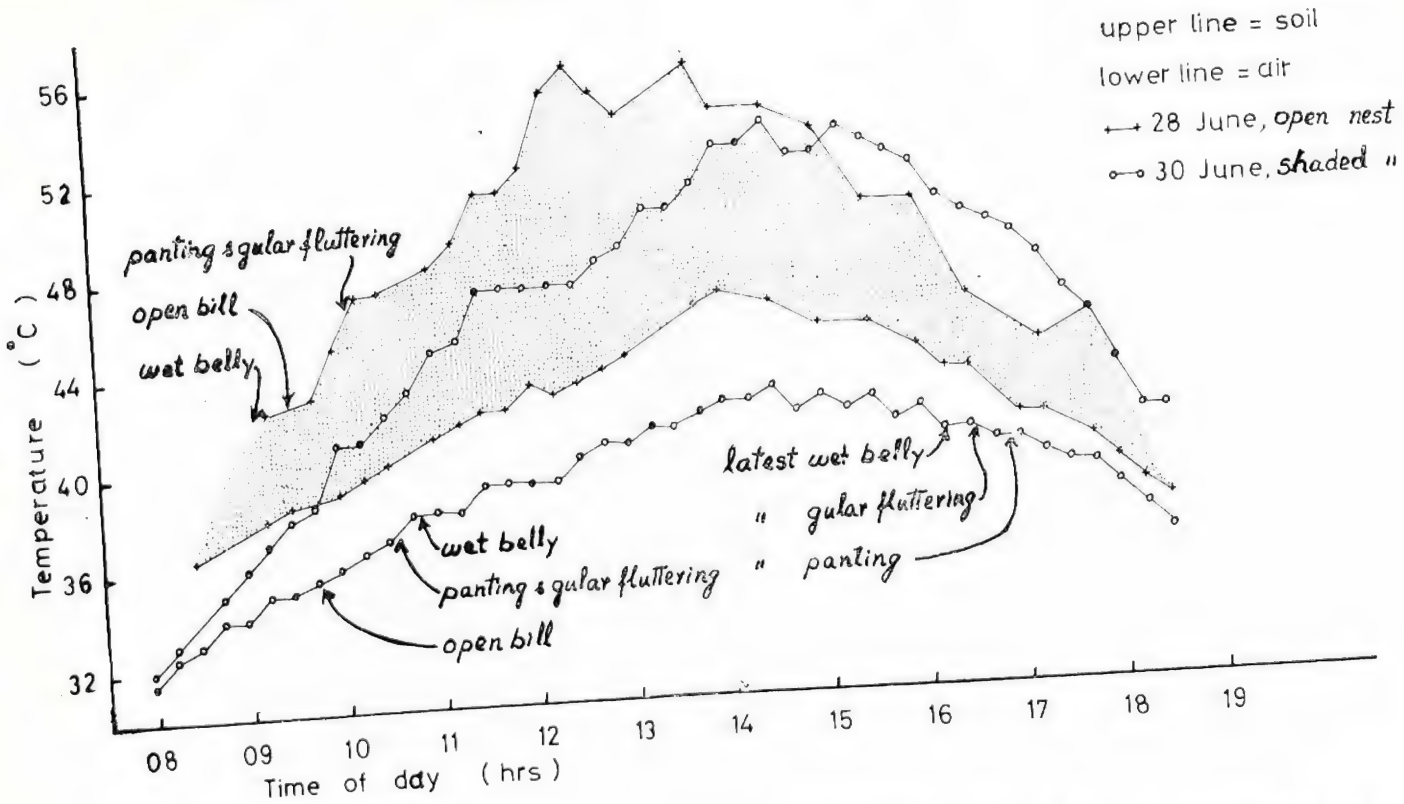

Fig. 8. The onset and termination of panting, gular fluttering, and wetting of belly feathers in an open and a shaded nests on 28 and 30 June respectively with soil and air temperatures.

Fig. 9. Male with belly feathers soaked in water settling on eggs.

Fig. 10. Female with soaked belly feathers just settled on eggs.

NEST RELIEF

The nest relief was a simple one typical of Charadriiformes. The incoming bird landed at a distance and walked or ran to nest, when close to nest the sitter got up walked or ran a few steps and took to wings calling out a few times. The female of shaded nest many times landed close to nest and scared the male to jump out from nest. During changeover no physical contact of sexes noticed in open nest, however, the female of shaded nest coming for incubation on several occassions pushed male with bill before taking over duty. Although the sitter left nest usually after the close approach of its mate, on a hot day female attending shaded nest for 51 and 61 minutes left it when incoming male was about 15 and 20m away respectively from nest. This happened around noon and on both occassions male rushed to nest and covered eggs.

NEST MAKING

On all the four occassions the female, which was on nest for the last evening sitting, when terminated the attentiveness picked up items like dried vegetable bits and threw them over the back towards nest while walking away from nest. This side throwing was not observed on the part of outgoing bird at any other time.

In the afternoon on a few times female sitting on nest picked up nest materials within the reach of its bill from the side of or near nest and dropped them in nest or from one side to other. Once it occurred in morning. The male did nest making only once (open nest) at the close of a long sitting around noon.

NEST TEMPERATURE

On 23 June at 1400, soon after the bird left nest, a mercury thermometer placed in between eggs-the mercury bulb resting on nest material-in open nest showed 44°C. Then the mercury bulb pierced completely into the compact sand close to nest recorded 54°C.

DISCUSSION

Exposed ground nesting of Kentish Plover in arid-zone with its attendant intense solar radiation and high environmental temperature

calls for utmost vigilance on the part of birds. The eggs face death if left exposed even for a short time. This makes continuous coverage of eggs a necessity. As a result cent percent nest attentiveness is noted during day (Fig. 4) Similar complete coverage has been eariler reported for open ground nesting Charadriiformes . **C. alexandrinus** (Rittinghaus 1956), **C. tricollaris** (Macdonald 1957, quoted by Serventy 1971), **Stiltia isabella** (Maclean 1976), **Vanellus indicus** (Naik **et al.** 1961), **Rhinoptilus africanus** (Maclean 1967), **Sterna fuscata** (Howell & Bartholomew 1962) and **Larus argentatus** (Drent 1970). Norton (1972) found the same nest coverage in the single-sex incubating **Calidris melanotos,** two-sex incubating **C. alpina, C. bairdi,** and **C. pusilla** in 24-hour-sunlight arctic summer at night where the eggs are to be protected from chilling in the extreme cold.

The daytime maximum single nest attentiveness recorded by us for both sexes (female 86 minutes, male 85 minutes) are very low compared to the same observed in France (between 0915 and 2115 with mid-day temperature 10.2°C; female over ten hours. male six hours, Rittinghaus 1956). This shows that although the birds are capable of longer sitting at a lower Ta, the prevailing extreme Ta in arid-zone makes it impossible for them doing so.

At the nesting ground the daytime Ta (soil 32-56°C, air 32-46°C, Fig. 8) was much higher than the body temperature of Kentish Plover, which is assumed to be close to that of related Ringed Plover **C. hiaticula** 40.0°C (Udvardy 1953). Keeping eggs at its optimum developing temperature (34-39°C, Drent 1975) and regulating bird's own temperature in an extremely high Ta, when radiational gain also occur, are extremely vulnerable problems to be confronted by the incubating bird. Practically all the mechanisms which are known to reduce heat stress in birds, namely panting, gular fluttering, wetting of belly feathers. opening of wing bend, raising of scapular and nape feathers, and sitting with back to the sun (Dawson & Hudson 1970) . are utilized by Kentish Plover sitting on eggs.

The first visible response to heat stress was the open-bill panting. This was sooner or later followed by gular fluttering and wetting of belly feathers. In the case of open nest soaking of belly feathers occurred first and possibly this delayed the onset of panting and gular fluttering. It appeared that the bird was unable to withstand the thermal stress by panting and gular fluttering alone and therefore had

to resort to the soaking of belly feathers. The gular fluttering does not appear to have been reported earlier for Kentish Plover.

J. Walters (per. comm.) of the Netherlands - who had made extensive study on the breeding biology of Kentish Plover by capturing and marking them, making some hundred hours of observation from hide on breeding birds - informs us that he has not observed the belly feathers wet or anything resembling wetting of feathers. However, there is an important observation by Gatter (1971) in West Germany on Little Ringed Plover **C. dubius** carrying water (in soaked belly feathers) to young hatched on a 'very hot' German day with 29.2°C, which is suggestive of the existence of wetting tendency even in European breeding population.

Other activities which augment heat dissipation noted in the incubating Kentish Plover were the opening of wing bend, scapular, and nape feathers, and the general orientation of the sitting bird facing away from the sun. Although the scapular and nape feathers were opened up in refreshing wind, these were kept closed in hot wind.

To cope with the extreme Ta, despite all the above heat dissipating methods, Kentish Plover also had to make constant changeover and to shorten the duration of average single nest attentiveness, as evidenced by the data on shaded nest for two days with different Ta (Table 1), and on open and shadad nest for the same period and day (Table 2).

The nest material seems to serve a dual insulative role by preventing the excessive soil temperature reaching the eggs during day and at night loosing of heat from eggs to soil, when soil temperature is lower than that of eggs under incubation.

It is apparent that only at night and in the cooler part of morning the bird applies heat to eggs, rest of the time it tries either to shade or take away the above-normal heat from eggs.

SUMMARY

Observations on the daytime activities of incubating Kentish Plovers **Charadrius alexandrinus** in an open and a shaded nests in an arid-zone are presented and discussed.

In addition to the major sources of evaporative cooling by panting and gular fluttering, Kentish Plover also soaks the belly feathers prior to incubation to withstand the extreme thermal stress in its nest microclimate. Further to augment heat dissipation the bird opens up wing bend, scapular and nape feathers, and sit on nest with back to the sun.

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الخـلاصـــــة

يتناول هذا البحث عرض ومناقشة لفعاليات طير الزقزاق الاسكندرانى **(Charadrius alexandrinus)** خـلال فتـرة الحضانـة تحت تأثـير البيئة الصحراوية الجافـــة .

لقد لوحظ انه بالاضافة الى اللهاث او ارتعاد منطـقة الذقـن والزور كوسيلة للتبريد يعمد اليها الطير لتحمل الحرارة العالية فانه يقوم ايضـا بنقع ريش المنطقة البطنية بالماء قبل البدء بالحضانة لنفس الغرض . كمـا ان الزقزاق الاسكندرانى يعمد الى فتح ريش الجناح ، الكتف ومؤخرة العنق والجلوس بالاتجاه المعاكس لاشعة الشمس للتخلص من الحرارة العاليـة .